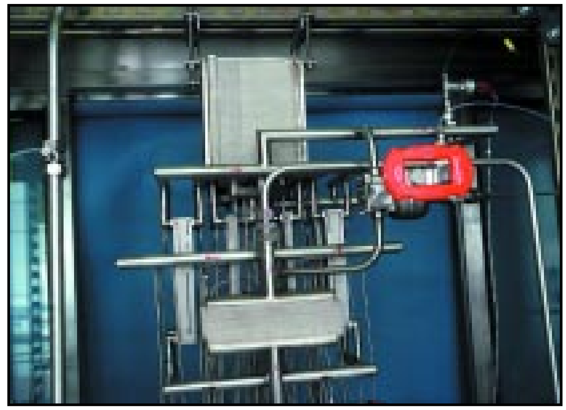
New technology processes liquid fuel into hydrogen for fuel cell vehicles

OAAT ACCOMPLISHMENTS

Small, Efficient Microchannel Fuel Processors

Challenge

Fuel-flexible onboard processors are being developed to help bring fuel cell vehicles to market faster. Such devices use a chemical system to turn gasoline and alternative fuels into hydrogen for use in fuel cells. To become commercially feasible, however, they must be made smaller, lighter, and more efficient.



Microchannel reactor-based onboard processors that reform currently available fuels into hydrogen may help speed the introduction of fuel cell vehicles.

Technology Description

A new class of process technology, based on microfabricated heat exchangers and reactors, shows significant promise for use in compact, onboard hydrogen generation systems for fuel cell vehicles. Microchannel reactor-based fuel processors are small, efficient, modular, lightweight, and potentially inexpensive. Because of their unique heat transfer and mass transport properties, these units operate more efficiently than larger conventional chemical reactors.

Accomplishments

Under the sponsorship of the U.S. Department of Energy and the Defense Advanced Research Projects Agency (DARPA), researchers at Pacific Northwest National Laboratory (PNNL) have demonstrated the technical feasibility of using microthermal and chemical systems for energy conversion and chemical processing:

- A microchannel steam reforming system, consisting of a four-cell reactor, multistream heat exchangers, and water/fuel vaporizers, that supports a 20-kW fuel cell and achieves 83-85% fuel processor efficiency on iso-octane.
- Compact microchannel heat exchangers with extremely high convective heat transport coefficients and low pressure drops.
- Microchannel catalytic reactors with millisecond residence times and reduced production of unwanted secondary reaction products.
- Microchannel separations units that reduce CO_2 and CO concentrations to very low levels.
- Low-cost lamination methods for fabricating microchannel devices.

Benefits

Onboard hydrogen production will enable the use of liquid fuels already available in the marketplace, eliminating the need to store hydrogen in fuel cell vehicles.

The compact, integrated steam reforming subsystem is designed to conserve heat generated in the reforming and combustion system, so that the fuel cell system faces little or no additional energy penalties.

The low temperatures used in the subsystem support the use of lower-cost materials, such as 316L stainless steel, instead of the materials required by other onboard fuel reforming systems, which typically operate at combustion temperatures of 1000° C.

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Awards

R&D Magazine chose this technology for a R&D 100 Award in 1999.

Future Activities

Current results demonstrate the potential for extremely compact hydrogen production systems (less than a cubic foot in size) for automotive fuel cells; however, substantial development effort is needed to realize complete systems:

- Size, weight, and cost will be reduced by increasing the catalyst loading per unit hardware volume and significantly lowering the amount of stainless steel used. The target cost for the improved system is $4 to $10 per kilowatt.
- The current integrated steam reforming subsystem will be scaled up to demonstrate highly efficient operation at 50 kW and higher fuel cell output at a target pressure drop of less than 0.1 psi.
- The iso-octane research fuel will be replaced by transportation fuels available in the marketplace.

Partners in Success

- Defense Advanced Research Projects Agency
- Pacific Northwest National Laboratory